Cultivation of Australian aquatic insectivorous plants

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I have been growing aquatic *Utricularia* since 2009, and have always been lucky in how well they grow; it seems they are more adaptable than one would initially think. Last year just prior to the 2014 ICPS conference in Cairns, I offered to show some local sites to a few of the attendees, one site was my collection, the rest wild. During the drive from my collection to the conference, my passenger, Darren Cullen, suggested I do a quick article on one of the ponds I use, thinking this would be far too short and dull I decided to expand to a basic cultivation guide.

I have always been inquisitive, resulting in the death of many a plant, but all in the name of curiosity and improvement, so in my opinion justified. This is a very concise and basic summary of the main methods I have utilised and learnt over the years to better grow my collection.

I will start with what aquatic carnivores I will be covering, *Utricularia aurea*, *australis*, *gibba*, *stellaris*, and *Aldrovanda*. I also use *Utricularia uliginosa*, *bifida*, *limosa*, *dichotoma*, and *monanthas* as affixed aquatics at depths of 1-120 cm, although I have recorded wild *uliginosa* as deep as 2.3 m in the wild and have no doubt they would grow deeper, providing the irradiance was supplied.

All will grow together in the one pond, tank, or dam, so the size is not a major issue. I have grown *U. gibba*, *uliginosa*, and *bifida* in containers as small as 100 ml, and setup new dams with local variants of all but *Aldrovanda*. All will grow in a depth from 1 cm to 2 m happily, providing other conditions are right, *bifida* must be attached to timber or the substrate, but the rest are happy as suspended aquatics, including *U. uliginosa* which is at home amongst *U. gibba* clumps.

For a standard 2- or 3-foot tank, a 3-5 cm layer of your chosen substrate is added, I prefer what is labelled as premium potting mix and *Typha* leaves, as it is cheap, effective, and long lasting. Then add a 2-4 cm layer of clean sand as an anchoring base for companion plants as well as to hold down the initial substrate. I have tried various grain sizes and found it makes no real difference.

The water is then added carefully; then let the tank settle for a minimum of 3 days, or ideally 2-3 weeks to help create a stable environment, allow any particles to settle, and any chemicals to mix in.

Table 1.

Summary of a standard 1 m tank	
Water depth	1-200 cm
Water pH	5.6-8.7 (optimum is 6.2-6.6)
Water temperature	10-42 °C
Substrate in order of success	1. sphagnum moss (2-3 cm) 2. Premium potting mix and *Typha* leaves (3-5 cm) 3. premium potting mix (2-4 cm) 4. pine bark chips (3-4 cm) 5. *Typha*/grass/reed leaves (2-3 cm lightly compressed) 6. peatmoss (2-3 cm) 7. clay (5-6 cm as this relies on companion plants) All covered by a thin 2-4 cm layer of sand or gravel as anchorage for companion plants/*Utricularia* and to hold down substrate.
Irradiance	Full sun all day, full morning sun and bright light. 50% shade cloth receiving full sun all day seems to be optimal.

Table 2.

Accompanying plants		
Baloskion tetraphyllum, *Baumea*, *Chorizandra cymbaria*	Pipe grass	These three species work well in dams, ponds in excess of 100 L, or potted in small tanks/ponds. They allow anchorage and decaying matter adds to acidity and nutrients of the water.
Eleocharis	Pincushion grass	Only suitable for shallow setups less than 10 cm deep. Alternatively attractive in a pot that is raised, certain species are fast spreading, others slow. Brilliant bog garden plants, easy germinating, not too competitive and attractive.
Marsilea	Nardoo	Thrives in depths of 1-40 cm, can get out of control and choke out *Utricularia* if not controlled in smaller setups, an array of attractive specimens exist in the *Marsilea* group.
Nelumbo	Lotus lily	Limited to larger setups such as dams or large ponds, although they form clumps are rather spaced and well suited for aquatic carnivores to grow at the bases of. Also as a stolonous species release higher levels of CO_2.
Nymphaea	waterlily	Best in ponds deeper than 40 cm, but small species work well in depths as low as 5 cm, attractive and aid in protection from birds and strong sun in open setups, may get out of control and need to be removed bi- to tri-annually.
Nymphoides	False waterlily	Although typically much faster growing than *Nymphaea*, *Nymphoides* die off faster, resulting in less competition, and are usually smaller, they are the water lily of choice in small setups.
Ottelia ovalifolia	Swamp lily	Again smaller than most *Nymphaea*, attractive, offers avian protection and anchorage. These plants are happy in 5 cm to 2 m deep water.
Phragmites australis, *Juncus*	reed	Best suited to larger setups, can be a nuisance if not potted and confined. I also like to cut off inflorescences as the seeds are easily spread and readily germinate.
Potamogeton	Pond weed	Can get out of control, certain species are preferable due to varied growth rates. These plants are used for aesthetics and anchorage. They are happy in a 5 L bowl to a 100,000 L lake.
Typha domingensis	Bull rush	Depths of 0-150 cm, easily contained in solid pots, long pots work best, their stolonous nature also adds to the CO_2 and plants provide shade and wind protection
Vallisneria australis	Water grass	Aesthetics is the only reason I use this plant, predominantly in glass aquarium setups, it is the proffered nursery for small shrimp and fish.
Pistia stratiotes	Water lettuce	In confined aquarium only, not in open ponds due to risk of spreading; periodically removed to prevent overcrowding; (removed plants must burnt), extreme care must be taken with this species and it should only be grown in a container with a lid or indoors. The hanging roots provide breeding habitat for prey such as daphnia and allow the plants to absorb massive amounts of nutrients. The divisional rate of these plants can be used to predict the nutrient level of the water.

Table 2. Continued.

Top three hazardous plants		
Hydrilla		Can easily choke out *Utricularia* and *Aldrovanda*, hard to remove from a collection, in my opinion unattractive.
Lemna	Duck weed	Although this plant acts in a similar manor to *Pistia*, in that it is excellent at absorbing nutrients, they mat the surface and block all light. *Lemna* is also extremely hard to eradicate and quickly spreads to any water vessel, in the case of greenhouse invasions to water trays, into bromeliads and even across flooded bog gardens.
Hymenachne amplexicaulis	Hymanachne	Fast growing, easy spreading, as a result chokes out other flora.
Fauna		
Unknown	Horn snail	Small snails full grown at 4-5 mm, these small species seem unable to consume plants and seem limited to algae
Atyid shrimp	Creek shrimp	Fast breeding, smaller specimen preyed on by *Utricularia* and *Aldrovanda*. Some are attractive and entertaining to watch
Holthuisana	Fresh water crab	Small freshwater crabs that thrive in tanks and ponds, they are preyed on by insectivorous plants when young, older crabs prey on tadpoles and toad-poles, two deadly threats when in large numbers
Dragon fly or damselfly		I allow the larvae to build up as the parents predate potential threats such as aquatic moth and mosquito and the young do no damage
Ranata, *Lethocerus*	Water scorpion	Smaller individuals provide prey, whilst larger specimen are entertaining to watch and predate potential threats
Hydaticus and Macrogyrus	Water beetles and skaters	Again provide food and predate potential threats
Daphnia		Provide food and help control algae
Neosilusurus, *Bunocephalus*, *Pterygoplichthys*.	catfish	Like all fish they must only be used in small quantities, cat fish have an immense effect on algae and are a must have in ponds in excess of 100 L.
Melanotaenia, *Mogurnda*, *Oxyeleotris*, *Poecilia*	Rainbow fish, gudgeon, cod and guppy	These fish are predacious and attractive; their fry offer food for insectivorous plants. Rainbow fish and guppy must be controlled as they will rapidly form large colonies if not managed. Gudgeon and cod are slow moving and slow breeding predacious fish, for this reason they do little physical and chemical damage to ponds and tanks.
Betta	Fighter fish	These work well in setups between 5 and 20 L, any smaller and they typically pollute the water to fast, any larger and they seem uncomfortable, but they are happy as a solitary fish and predate anything they can fit in their mouth.
Faunal species to avoid in setups less than 200 L		
Turtles		Faecal matter destroys the water chemistry and their size and movements destroys breaks plants.
Goldfish, koi, and other carp		
Ells and larger fish species		

Utricularia uliginosa is happy to grow as a permanent attached aquatic.

Small children tubs such as these are perfectly suited to being a shallow ponds and deep water trays, also note the cut back *Typha*, this does not harm the plants and the leaves may be dried and utilised as substrate.

After this, companion plants may be added. They are not a necessity, but are highly recommended. Now after another week, the pH should be recorded, target pH is 6.2-6.6. If the pH is too high, add dried *Sphagnum* — it will float for a few days then sink and increase the acidity. Alternatively, peat tea may be used or dried sedges or grass leaves stuffed in a stocking. If the pH is too acidic, simply bucket out some water and replenish with new water. Once the pH is stable, the *Utricularia* are added. This same method may be adopted for large ponds. I use 1 cup of peat/sphagnum to 3 L; so a 250 L pond takes about 84 cups (or 8-9 compressed peat blocks), however for small tanks ½ to 1 cup per liter is

A large share tank at the back of my greenhouse for *Utricularia uliginosa*, *dichotoma*, *bifida*, *aurea*, *australis*, *gibba*, *stellaris*, and *Aldrovanda*, to the left is a poison pack converted to a CO_2 reactor.

Small bowls (8 L or less) are best used in greenhouses or collections where localities need to be separate; here *U. gibba*, *australis*, *uliginosa*, and *bifida* can all thrive.

Old bath tubs are common in sheds of rural regions and make excellent bog gardens and ponds.

A standard pot, the substrate is 3 cups of premium potting mix, pH of 8.0-8.2, yet *Utricularia aurea* thrives 8 months; not surprising as wild plants are common in heavily fertilised ditches in cropland.

A decorative pond containing *Aldrovanda*, *U. aurea*, and *U. gibba*.

enough, otherwise two 25 L bags of standard potting mix per 250 L. In the ball park estimates are fine.

For small setups (less than 100 L), I find the addition of a simple CO_2 reactor to be a great benefit to the growth rate. They are also simple to make and benefit all aquatic plants (however not recommended if there are fauna such as fish or crustaceans). Another benefit of a CO_2 reactor in an aquarium or pond is to increase acidity. I like to use a CO_2 reactor that is less than ¼ the size of the pond or tank as any larger and the water chemistry will decrease. My mix is one 7 g yeast sachet to 2 cups of white sugar in 5 L of water.

To counter algae, I use horn snail, this is a minute species that does not feed on plants and can be brought from some pet stores, alternatively or with them small catfish work well, especially in larger bodies of water (in excess of 100 L), as do freshwater mussels. In smaller ponds and aquariums, nitrogen levels can easily climb too high with fish.

Companion plants can be used to reduce algae growth by absorbing excess nutrients, lessening intense light, regulating the temperature, and also help *Utricularia* growth by adding CO_2 when older leaves decay or through stolon growth.

Now for a novelty, but rather effective method, we started to make some ponds, or in a couple cases cattle troughs using the old rear tires from tractors. We cement the base to make a watertight area and treat as any other pond. We put rocks around to hide them in the gardens. These and old bath tubs are easily obtained in rural regions and work brilliantly as large, low maintenance ponds.